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Liquidity and resolution of uncertainty in the European carbon futures market

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ABSTRACT

We investigate whether liquidity introduces or helps resolve uncertainty in Phase I and the first year of Phase II of the European carbon futures market. We propose a distinction between 'absolute' or overall liquidity and that which is 'relative' to a benchmark. For this purpose, we suggest volume-weighted duration as a natural measure of trading intensity as a proxy for liquidity, and we model it as a rescaled temporal point process. The new model is called Autoregressive Conditional Weighted Duration (ACWD) and is shown to outperform its discrete modelling counterparts. Liquidity is found to play a dual role, with higher relative liquidity introducing uncertainty and higher absolute liquidity accelerating uncertainty resolution, thus, enhancing market efficiency.

1. Introduction

This paper investigates whether liquidity introduces or facilitates the resolution of uncertainty. If liquidity is linked to, or convey, information (Easley & O'Hara, 1992) some uninformed traders who observe variations in liquidity might believe that there is price unresolved information. Accordingly, some relative levels or variations of liquidity might induce uncertainty (price volatility). Upon greater ambiguity aversion the magnitude of the resulting volatility shock(s) would be expected to be greater. If liquidity exhibits such conditionality, then higher liquidity episodes relative to 'norm' or benchmark levels (e.g., annual, daily, or hourly averages, or levels dictated by uninformed investors) may induce uncertainty, while high general norm or benchmark levels may help resolve uncertainty by accelerating uncertainty resolution time. In this paper we recognise this likely dual role of liquidity, and use it to motivate an explicit distinction between 'absolute' and 'relative' liquidity, which may facilitate the determination of uncertainty. We model liquidity conditionality (parametrically) and use the trades of higher relative liquidity identified by this modelling to test (non-parametrically) whether this conditionality affects volatility.

From a microstructure point of view the market is seen as a price discovery and a liquidity provision mechanism (O'Hara, 2011), where information (Bagehot, 1971; Glosten & Milgrom, 1985; Kyle, 1985) and liquidity (Benston & Hagerman, 1974; Tinic, 1972; Tinic & West, 1972) are the main drivers of intraday price formation. Focusing on liquidity, relevant literature recognises a transitory effect on price formation due to 'inventory holding' (Amihud & Mendelson, 1980; Garman, 1976; Ho & Stoll, 1981, 1983; Stoll, 1978). Without disregarding this conventional role of liquidity, seen as a matching mechanism that results in transaction costs and is positively related to asset prices, O'Hara (2003) identifies a more complex role related to the risk of holding an asset. Specifically, systematic fluctuations in liquidity might be related to the presence of price unresolved information (Easley & O'Hara, 1992). This indicates that liquidity, as a non-price measure, conveys price related information (Kalaitzoglou & Ibrahim, 2013b) and might thus affect perceptions of risk and risk premia. If this risk is not fully diversifiable across assets, liquidity leakage (O'Hara, 2003) might increase ambiguity-induced (Easley & O'Hara, 2010) volatility.

The questions that naturally arise are: how sophisticated the trading patterns of various market participants are, and how they interact with each other. O'Hara (2003) argues that informed traders continuously move a partially revealing price equilibrium according to new

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information. Private or imperfect public information is continuously and partially revealed through trades. Further, public information, when not perfect, increases ambiguity and is not immediately incorporated into prices. Due to ambiguity, therefore, not everybody perceives the same signal in the same way and, thus, prices need a period of time to adjust. During this uncertainty resolution period, some uninformed traders observe and 'learn' from trading history and act upon sufficiently strong accumulated information, according to their portfolio needs, given that there is enough time till the information gets price resolved. They become more informed to the remaining uninformed and can exploit the newly extracted information but only within a limited time window till their advantage becomes obsolete. Their actions temporarily increase liquidity, which might accelerate price resolution or increase uncertainty and hence volatility. Consequently, this uncertainty resolution period can be thought of as a 'time game' among uninformed traders. Liquidity, therefore, cannot be considered independently from price discovery since they interact affecting price formation. The price discovery mechanism of the market can, thus, be seen as a continuously revealing price equilibrium, where information dissemination is not an instantaneous event but interacts with liquidity. Under this perspective, liquidity should exhibit some sort of conditionality.

Furthermore, organised markets are seen as a diverse information aggregation mechanism (Kyle & Viswanathan, 2008), where liquidity might increase market efficiency (Hayek, 1945) without necessarily increasing 'price accuracy' too.[2] According to O'Hara (2003), they also seem to implicitly recognise multiple roles for liquidity. Overall liquidity is understood to improve market efficiency, since it enables the easier incorporation of price related signals into prices. This implicitly assumes that information held by better informed agents is revealed through trading signals and thus, conditionality in liquidity might induce uncertainty. In this paper we explicitly distinguish between 'absolute' liquidity, defined as the overall volume of trading, from 'relative' liquidity, defined as different liquidity levels relative to a liquidity benchmark. We investigate liquidity patterns, where relative liquidity might induce uncertainty, the resolution time of which depends on absolute liquidity.

The first contribution of this paper is the explicit modelling of trading intensity (proxy for liquidity) as a rescaled temporal point process. Engle and Russell (1998) describe the dynamics of inter-arrival time of events as a dependent point process, and model it with the Autoregressive Conditional Duration (ACD) model. However, duration alone is not always sufficient in describing the intensity of trading, and event time needs to be modelled along with other variables of interest called *marks* (e.g., trade price or trade volume/size). Following the Autoregressive Conditional Intensity (ACI) framework of Russell (1999), Tay, Ting, Tse, and Warachka (2004) propose the Autoregressive Conditional Multinomial Duration (ACMD) model, which describes durations and associated marks as a temporal marked point process with discrete marks. Each state of a mark is thought of as a parallel point process, the realisation of which depends on past information. In parallel, Russell and Engle (2005) develop the Autoregressive Conditional Multinomial (ACM) framework, which jointly models arrival times and transition probabilities among the different stages of an associated discrete mark. The major limitation of these approaches is that marks with continuous distributions would require an infinite number of states.

This paper, instead, shifts the focus from event (transaction) time to events defined by a unit change in an associated mark. We use a kernel transformation of the mark to weigh or rescale durations. This produces a new measure of the waiting time for the arrival of a unit quantity of the mark. The new framework is called Autoregressive Conditional Weighted Duration (ACWD), and is used to model volume weighted duration as a better measure of trading intensity than duration alone. The conditional intensity (hazard function) of this natural measure of trading intensity depends upon past transformed durations and measures the instantaneous rate of the arrival time of a single unit of the mark. This extends the ACD framework of Engle and Russell (1998) in the sense that it enables the modelling of a marked point process as a univariate temporal point process.

The second contribution of this paper refers to the explicit distinction between 'absolute' and 'relative' liquidity and their differential impact on volatility and uncertainty resolution. We investigate the intraday volatility impact of high trading intensity episodes in Phase I (2005–2007) and the first year of Phase II (2008–2012) of the European carbon market, identified in Kalaitzoglou and Ibrahim (2013a). This market consists of distinct organised exchanges and trading phases with notably different, but increasing, levels of overall liquidity for the same commonly traded contracts. The total supply of traded emission allowances and credits is regulated (capped) and, even though allowances could not be carried forward from Phase I to Phase II ('banking restriction'), there has been an overallocation of allowances since market inception, affecting prices and liquidity.[3] This provides an ideal setting for investigating potentially different effects of the two types of liquidity. An increase (decrease) in volatility levels following a high trading intensity trade would indicate the introduction (resolution) of price relevant information, and this would capture the volatility impact of high relative liquidity. We further investigate the intraday resolution time of the volatility impact of high trading intensity trades. A shorter (longer) resolution period, when overall liquidity is higher, would indicate that higher absolute liquidity leads to increased (decreased) market efficiency, in the sense of faster information dissemination and uncertainty resolution.

To the extent that volume and duration convey information and liquidity, and inform subsequent bid and ask price quote setting, the new measure of volume-weighted duration relates directly to four of the five overlapping dimensions of liquidity: immediacy (speed of order execution, clearing and settlement), resiliency (the speed with which prices recover from a random uninformative shock), tightness (the cost of turning around a position within a short period of time) and depth (the size of an innovation in aggregate quantity traded). It may relate indirectly to breadth (numerous large orders) which could translate, at least partially, to faster large or block trade execution.[4] As higher 'general' trading activity is usually associated with greater depth and lower trading costs (Kalaitzoglou & Ibrahim, 2013b; and O'Hara, 2011), tightness and depth would be partially accounted for by a trading intensity measure, even though the direction of causality (from spreads or depth to trading intensity, or vice versa) may not be clear in a duration model without an explicit price dimension, such as the one suggested here, although it could be extended to include this dimension.[5]

The results indicate that there exist strong liquidity momentums, which drive intraday trading activity and price change volatility. Relatively higher trading intensity seems to be followed by increased volatility, which needs at least 7 min to be price resolved. These uncertainty shocks seem to be smaller in magnitude and to be absorbed relatively faster in more liquid environments. This highlights a major difference between absolute and relative liquidity. Higher relative liquidity is linked to higher presence of information and introduces uncertainty,

[2] A less regulated, highly manipulated market might be more liquid and thus, more efficient, in terms of incorporating manipulation into prices, yet assets are not necessarily priced according to fundamentals.

[3] See, for example, Alberola, Chevallier, and Cheze (2008), Mansanet-Bataller and Pardo (2008) and Kalaitzoglou and Ibrahim (2013a).

[4] Hence we include block trades in our data sample. For definitions of the rather 'slippery' concept of liquidity see, e.g., Kyle (1985), Grossman and Miller (1988) and Ranaldo (2001).

[5] Asymmetric information microstructure models attribute trading costs, including the bid-ask spread, to interacting information ('permanent') and liquidity ('temporary') related components that are further dissected into order processing, asymmetric information, inventory-carrying (immediacy), and oligopolistic market structure costs (Sarr & Lybek, 2002). Obviously, if price quote setting follows a 'learning' process from the recent evolution of order flow then the speed and size of trades would inform subsequent (variable) trade cost setting, and hence prices.